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PLANKTON ALGAE OF SOME LAKES OF WHATCOM COUNTY, WASHINGTON

GEORGE J. SCHUMACHER AND W. C. MUENSCHER

Whatcom County, Washington, is the extreme northwestern county of the United States. It is bordered on the west by Puget Sound, on the north by British Columbia, on the east by the main divide of the Cascade Mountains and on the south by Skagit County. In general topography, the ruggedness increases from west to east and varies in elevation from the low coastal area of the Puget Sound Basin to Mount Baker which towers 10,780 feet above sea level. The western part is mostly rolling uplands and alluvial stream valleys, which are replaced by the low rounded foothills in the central area, while Mount Baker and the Cascade Range dominate the western portion.

Three main rivers drain the county (Muenscher, 1941). The western part is drained by the Nooksack River and its three tributaries which originate in the glaciers of Mount Baker and empty into Bellingham Bay. The central and eastern parts of the county are drained southward by the Skagit River and the Baker River system while several streams drain to the north into the Fraser River. Lake Whatcom, the largest natural lake in the county, is drained directly into Bellingham Bay by Whatcom Creek.

The climate of Whatcom County is wet and temperate. The warming influence of the Japanese Current and the protecting heights of the Cascade Mountains help to make the Bellingham area a mild region for its latitude. In a ten year period the highest temperature recorded for Bellingham was 92° F. and the lowest was 2°F. In this same region, over a twenty-five year period, the average annual precipitation was 32.22 inches (U.S.D.A., 1941). Here the snow is usually light and melts quickly, and an average of 250 days of the year have neither rain nor snow (Mangum and Hurst, 1909).

In the higher mountainous altitudes the situation is different, with snowfall and cold wet weather being prevalent for a period of ten months. In the vicinity of Mount Baker Lodge the annual precipitation has averaged 110.96 inches for a period of ten years and in this region snow may persist all year around with some peaks being covered with ice caps or glaciers.

LAKES STUDIED

Collections were made in eighteen lakes located in the western half of Whatcom County. Lake Whatcom, about twelve miles long, Samish Lake, about four miles long, and Silver Lake, about one mile long, all have considerable stony and sandy shoreline and sandy bottoms. Terrell Lake, which proved to be the most fertile for this study, was drained in an attempt to provide muck land for farming in the early 1920's. This proved unsuccessful, however, and in 1949 a dam was constructed across its outlet and by December, 1950, the lake was again flooded and now covers over 500 surface acres. The other lakes are, for the most part, small and located in glacial depressions. In many places they are bordered by peat bogs. Their shores consist of floating moors and their bottoms are composed of organic or mucky accumulations. Nearly all the lakes support a considerable growth of aquatic flowering plants in shallow areas and near shore. The lakes from which the phytoplankton samples were studied are indicated on the map (fig. 1).

COLLECTIONS

The initial set of collections was made in the summer of 1929 by W. C. Muenscher. This collection was stored in a dark cabinet until 1948 when G. J. Schumacher used this material as a subject for a master's thesis and found therein a total of 152 species and 49 genera of algae (Schumacher, 1949). This collection did not include any samples from Baker, Barrett and Terrell lakes.

In 1949 Joanne P. Muenscher visited the area and made a second series of collections. This included samples from Judson, Samish, Silver, Whatcom, Willey's and Wisser lakes.

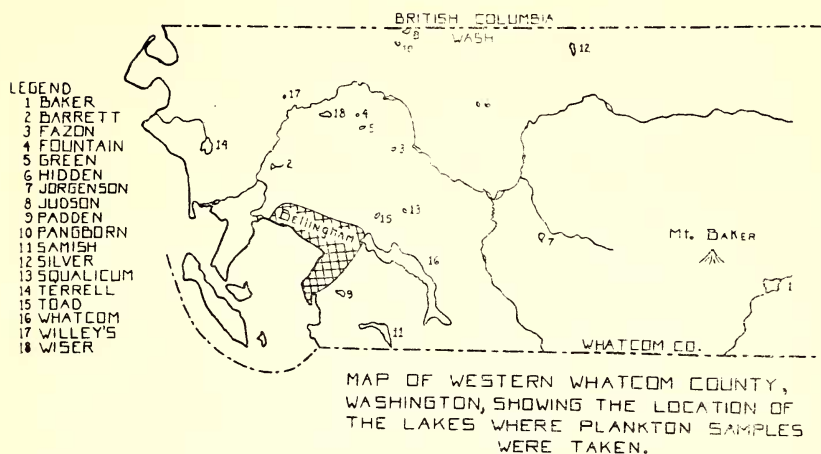


FIG. 1. Location of lakes where algae were collected in Whatcom County, Washington.

The third and final set of collections was made by W. C. Muen-scher and Dr. Babette I. Brown during the summer of 1950. Samples were taken from Baker, Barrett, Samish, Silver, Ter-rell, Whatcom, and Wisser lakes. Thus the material used in this report embraces a time span of twenty-two years, from 1929 to 1950.

The collections were made by using a plankton tow net of No. 20 silk bolting cloth to strain the water. Most of the tows were made in open water in the upper meter and wherever possible several tows were taken in different parts of each lake. The concentrated tows, each representing the strainings from approximately ten liters of lake water, were preserved in five per cent formalin in tightly stoppered bottles until examined. These collections are now filed with the Botany Department of Cornell University.

In any collection of phytoplankton there may be several algae from the benthos. A few algae, not plankton in habit, appeared in these collections. They are included in this study, however, for they may suggest what other types of algae may be found in the depths and about the shores of these lakes.

CLASSIFICATION

The classification of algae is not a clear or definite arrange-ment. No matter which classification is used, inter-relationships between the separated divisions exist. The system used in the following list is based largely upon that of G. M. Prescott (1951), in which the nature of the cell wall, the pigments found in the cell, the type of reserve food, and the means of reproduc-tion are taken into consideration.

In the following list one or more numbers appear after each individual alga. The numbers correspond with those assigned

to the lakes on the map (fig. 1). If an alga was found only in the 1929 collections no letter will appear after the number, if a letter follows a number this key should be used.

- a. Found in the 1949 collection.
- b. Found in the 1950 collection.
- c. Found in the 1929 and 1949 collections.
- d. Found in the 1949 and 1950 collections.
- e. Found in the 1929, 1949 and 1950 collections.
- f. Found in the 1929 and 1950 collections.

Thus the numbers show the distribution of the species by lakes throughout the county and the letters denote the date of the collections in which they were found.

Division—CYANOPHYTA. Class—MYXOPHYCEAE
Order—CHROOCOCCALES

1. Chroococcaceae

- APHANOCAPSA ELACHISTA W. & G. S. West, 1b, 14b.
 A. GREVILLEI (Hassel) Rab., 10, 14b, 16a.
 A. RIVULARIS (Carm.) Rab., 12, 17.
 A. NIDULANS P. Richter, 12a.
 A. PRASINA A. Braun, 5.
 A. STAGNINA (Sprengel) A. Braun, 8, 10, 11.
 CHROOCOCCUS LIMNETICUS Lemm., 6, 8, 11a, 12c, 15, 16, 17a.
 C. MINUTUS (Kuetz.) Naeg., 4, 5, 8, 9, 10, 16, 17.
 C. TURGIDUS (Kuetz.) Naeg., 10.
 COELOSPHAERIUM DUBIUM Grunow, 12a.
 C. NAEGELIANUM Unger, 14b, 16e, 18a.
 GLOEOTHECE RUPESTRIS (Lyngb.) Bornet, 8.
 MERISMOPEDIA GLAUCA (Ehr.) Naeg., 16b.
 M. TENUISSIMA Lemm., 17a.
 MICROCYSTIS AERUGINOSA Kuetz., 12a, 17a, 18a.
 M. AERUGINOSA var. MAJOR (Wittr.) G. M. Smith, 15.
 M. FLOS-AQUAE (Wittr.) Kirchn., 7, 8, 10, 11, 17a.

Order—HORMOGONALES

1. Oscillatoriaceae

- ARTHROSPIRA GOMONTIANA Setch., 11.
 A. JENNERI (Kuetz.) Stiz., 7.
 LYNGBYA SPIRULINOIDES Gomont, 16a.
 OSCILLATORIA AMPHIBIA Ag., 9.
 O. CHALYBEA Mert., 2b.
 O. LIMOSA (Roth.) Ag., 16, 2b, 4, 5, 7, 14b, 18.
 O. PRINCEPS Vauch., 2b, 7, 14b.
 O. TENUIS Ag., 4, 5, 6, 9, 11, 13, 16f, 17a.
 PHORMIDIUM NAVEANUM Grunow, 5.
 SPIRULINA MAJOR Kuetz., 11.
 S. NORDSTEDTII Gomont, 12.
 S. PRINCEPS (W. & G. S. West) G. S. West, 15.

2. Nostocaceae

- ANABAENA AFFINIS Lemm., 4, 12a.
 A. CIRCINALIS Rab., 5, 10, 18.
 A. FLOS-AQUAE (Lyngb.) Breb., 13.
 A. LEMMERMANNI P. Richter, 12a, 15, 16d, 18.
 A. LIMNETICA G. M. Smith, 13.
 A. SPIROIDES Klebahn, 18a.
 A. SPIROIDES var. CRASSA Lemm., 5, 13.
 A. VARIABILIS Kuetz., 12.

A. sp., 9, 11a, 14b, 16b, 17a.

APHANIZOMENON FLOS-AQUAE (L.) Ralfs, 18b.

CYLINDROSPERMUM MINUTISSIMUM Collins, 8.

NODULARIA HARVEYANA (Thw.) Thur., 13, 16.

3. Stigonemataceae

HAPALOSIPHON HIBERNICUS W. & G. S. West, 17a.

H. PUMILUS (Kuetz.) Kirchn., 8.

4. Rivulariaceae

GLEOTRICHIA ECHINULATA (J. E. Smith) Richter, 14b, 18a.

Division—CHLOROPHYTA Class—CHLOROPHYCEAE

Order—VOLVOCALES

1. Volvocaceae

EUDORINA ELEGANS Ehr., 2b, 12a, 14b, 16b.

PANDORINA MORUM (Muell.) Bory, 12a, 14b, 16a.

PLEODORINA CALIFORNICA Shaw, 18a.

VOLVOX AUREUS Ehr., 13.

V. GLOBATOR L., 13, 14b, 18a.

V. MONONAE G. M. Smith, 5, 13.

Order—TETRASPORALES

1. Palmellaceae

GLOECYSTIS GIGAS (Kuetz.) Lag., 1b, 2b, 14b.

SPHAEROCYSTIS SCHROETERI Chod., 12a, 14b, 16d.

Order—MICROSPORALES

1. Microsporaceae

MICROSPORA PACHYDERMA (Wille) Lag., 17a.

M. STAGNORUM (Kuetz.) Lag., 8, 9.

M. TUMIDULA Hazen, 17.

M. WILLEANA Lag., 6, 8.

Order—CHAETOPHORALES

1. Chaetophoraceae

CHAETOPHORA ELEGANS (Roth) Ag., 12.

2. Coleochaetaceae

CHAETOSPHAERIDIUM GLOBOSUM (Nordst.) Klebahn, 1b, 17.

Order—OEDOGONIALES

1. Oedogoniaceae

BULBOCHAETE sp., 1b, 8c, 10, 11a, 12c, 14b, 15, 16, 17c.

OEDOGONIUM CLAVATUM Hallas, 4.

O. SUECICUM Wittr., 17.

O. sp., 1b, 2b, 5, 7, 8, 9, 12, 13, 14b, 16, 17, 18c.

Order—CHLOROCOCCALES

1. Hydrodictyaceae

PEDIASTRUM ARANEOSUM var. RUGULOSUM (G. S. West) G. M. Smith, 8a, 10, 14b.

P. BIRADIATUM Meyen, 5, 16a.

P. BORYANUM (Turp.) Menegh., 4, 5, 7, 8, 10, 11, 12, 16.

P. BORYANUM var. UNDULATUM Wille, 2b.

P. DUPLEX Meyen, 2b, 12a, 14b, 16b.

P. DUPLEX var. COHARENS Bohlin, 1b, 2b, 14b, 16b.

P. DUPLEX var. GRACILLIMUM W. & G. S. West, 12a.

P. INTEGRUM Naeg., 6.

P. TETRAS (Ehr.) Ralfs, 8a, 14b, 17a.

SORASTRUM SPINULOSUM Naeg., 14b.

2. Coelastraceae

- COELASTRUM CAMBRICUM Arch., 8c, 10, 11, 17a.
C. MICROPORUM Naeg., 11.

3. Oocystaceae

- ANKISTRODESMUS FALCATUS (Corda) Ralfs, 8, 12, 17c.
A. FALCATUS var. MIRABILIS (W. & G. S. West) G. S. West, 8, 12, 18a.
DICTYOSPHAERIUM EHRENBERGIANUM Naeg., 14b.
D. PULCHELLUM Wood, 8a, 17a.
DIMORPHOCOCCUS LUNATUS A. Braun, 16c.
KIRCHNERIELLA LUNARIS (Kirchn.) Moeb., 12a, 14b.
K. LUNARIS var. IRREGULARIS G. M. Smith, 12.
K. OBESA (W. West) Schmidle, 10.
NEPHROCYTIUM AGARDHIANUM Naeg., 14b.
QUADRIGULA PFTTZERI (Schroder) G. M. Smith, 12a.
TETRAEDON CAUDATUM (Corda) Hansg., 12a.
T. REGULARE var. LONGISPINUM (Reinsch) DeToni, 1b, 14b.

4. Scenedesmaceae

- SCENEDESMUS ABUNDANS (Kirchn.) Chod., 7a.
S. ACUTIFORMIS Schroeder, 7.
S. ARCUATUS Lemm., 12a.
S. ARCUATUS var. PLATYDISCA G. M. Smith, 14b.
S. ARMATUS (Chod.) G. M. Smith, 2b, 7, 14b.
S. BIJUGA (Turp.) Lag., 6, 7, 12, 14b, 17.
S. BRASILIENSIS Bohlin, 2b.
S. DIMORPHUS (Turp.) Kuetz., 11, 17a.
S. LONGUS Meyen, 7, 8a.
S. OBLIQUUS (Turp.) Kuetz., 2b, 9.
S. QUADRICAUDA (Turp.) Breb., 2b, 4, 5, 7, 8, 10, 11, 16.
S. QUADRICAUDA var. QUADRISPINA (Chod.) G. M. Smith, 10, 14b.

Order—ZYGNEMATALES

1. Zygnemataceae

- MOUGEOTIA sp. 1b, 2b, 4, 8, 12, 15, 16, 18.
SPIROGYRA GRACILIS (Hass.) Kuetz., 9.
ZYGNEMA sp., 1b, 5, 12a.

2. Mesotaeniaceae

- SPIROTAENIA CONDENSATA Breb., 8.

3. Desmidiaceae

- ARTHRODESMUS SUBULATUS Kuetz., 5.
A. TRIANGULARIS Lag., 5, 17.
A. TRIANGULARIS var. INFLATUS W. & G. S. West, 17a.
A. sp., 1b.
CLOSTERIUM ACEROSUM (Shrank) Ehr., 1b.
C. CUCUMIS Ehr., 4.
C. DIANAE var. ARCUATUM (Breb.) Rab., 8.
C. DIDYMOTOCUM Corda, 17a.
C. INTERMEDIUM Ralfs, 14b.
C. KUEZINGII Breb., 14b.
C. LEIBLEINII Kuetz., 2b, 9, 11.
C. LINEATUM Ehr., 14b.
C. LUNULA (Muell.) Ralfs, 14b.
C. MONILIFERUM (Bory) Ehr., 1b, 2b, 5, 9, 12, 14b.
C. PARVULUM Naeg., 5.
C. PRITCHARDIANUM Arch, 1b, 2b.
C. RALFSII var. HYBRIDUM Rab., 8.

- C. STRIOLATUM Ehr., 8.
C. ULNA Focke, 8.
C. sp., 8a, 14b, 18a.
COSMARIUM AMOENUM Breb., 8.
C. BIOCULATUM Breb., 17.
C. BLYTHII Wille, 14b.
C. CIRCULARE Reinsch, 14b.
C. CONTRACTUM Kirchn., 16a, 17a.
C. CONTRACTUM var. PAPILLATUM forma MINOR G. M. Smith, 11a, 16a.
C. DENTICULATUM forma BORGEI Irene-Marie, 14b.
C. DEPRESSUM (Naeg.) Lund., 14b.
C. GALERITUM Nordst., 14b.
C. HAMMERI Reinsch, 9.
C. MARGARITIFERUM Menegh., 16.
C. NOTABILE Breb., 6, 9.
C. OVALE Ralfs, 8a.
C. PORTIANUM Arch., 14b.
C. PSEUDOPYRAMIDATUM Lund., 8.
C. PYRAMIDATUM Breb., 8.
C. RENIFORME (Ralfs) Arch., 18a.
C. RENIFORME var. COMPRESSUM Nordst., 6, 12.
C. SUBCOSTATUM Nordst., 14b.
C. SUBCUCUMIS Schmidle, 12.
C. TAXICHONDRUM Lund., 8.
C. TETRAOPHTHALMUM Breb., 7.
C. TUMIDUM Lund., 8.
C. UNDULATUM var. CRENULATUM (Naeg.) Wittr., 17a.
C. UNDULATUM var. MINUTUM Wittr., 9.
C. sp. 14b, 16b.
DESMIDIUM APTOGONUM Breb., 14b.
D. APTOGONUM var. ACUTIUS Nordst., 14b.
D. BAILEYI (Ralfs) Nordst., 14b.
D. SWARTZII Ag., 13, 16.
DOCIDIUM UNDULATUM Bail., 8.
EUASTRUM AFFINE Ralfs, 8a.
E. ANSATUM Ralfs, 17.
E. BIDENTATUM Naeg., 8a.
E. CRASSUM (Breb.) Kuetz., 8.
E. CUNEATUM Jenner., 8.
E. DENTICULATUM (Kirchn.) Gay, 11.
E. DIDELTA (Turp.) Ralfs, 17.
E. INSULARE (Wittr.) Roy, 14b.
E. INTERMEDIUM Cleve, 8.
E. PULCHELLUM Breb., 8.
E. VALIDUM W. & G. S. West, 8a.
E. sp., 14b.
GYMNOZYGA MONILIFORMIS Ehr., 14b.
HYALOTHECA MUCOSA (Dillw.) Ehr., 12a.
MICRATERIAS AMERICANA (Ehr.) Ralfs, 17a.
M. APICULATA (Ehr.) Menegh., 8, 14b.
M. APICULATA var. FIMBRIATA forma SPINOSA (Bissett) W. & G. S. West, 14b.
M. DENTICULATA Breb., 17c.
M. DEPAUPERATA var. KITCHELII (Wolle) W. & G. S. West, 8a.
M. MURICATA (Bail.) Ralfs, 5, 8, 16.
M. RADIATA Hass., 1b, 14b, 16.
M. TRUNCATA (Corda) Breb., 17.
NETRIUM DIGITUS (Ehr.) Itz. & Rothe, 17a.
ONYCHONEMA LAEVE Nordst., 1b.

- O. LAEVE var. LATUM W. & G. S. West, 14b.
 PENIUM LIBELLULA (Focke) Nordst, 8a.
 P. NAVICULA Breb., 8.
 PLEUROTAENIUM EHRENBERGII (Breb.) De Bary, 8, 14b.
 P. NODOSUM (Bail.) Lund., 8.
 P. TRABECULA (Ehr.) Naeg., 7, 8.
 SPHAEROZOSMA GRANULATUM Roy & Biss, 14b.
 SPONDYLOSIMUM MONILIFORME Lund., 12a.
 STAUROSTRUM ANATINUM Cooke & Wills, 4.
 S. ARACHNE var. CURVATUM W. & G. S. West, 8.
 S. ARCTISCON (Ehr.) Lund., 1b, 2b, 7, 14b, 16.
 S. BREVIACULEATUM G. M. Smith, 17.
 S. CERASTES Lund., 8.
 S. CURVATUM W. West, 1b.
 S. CUSPIDATUM Breb., 2b, 12a, 17a.
 S. FURCIGERUM Breb., 14b, 16.
 S. GRACILE Ralfs, 1b, 3, 4, 5, 11a, 12, 16, 18.
 S. HEXACERUM (Ehr.) Wittr., 14b.
 S. JOHNSONII W. & G. S. West, 14b.
 S. MEGACANTHUM Lund., 8.
 S. MUTICUM Breb., 14b.
 S. PARADOXUM Meyen, 17a.
 S. POLYMORPHUM Breb., 17.
 S. SETIGERUM Cleve, 14b.
 S. TELIFERUM Ralfs, 8a.
 S. TETRACERUM (Kuetz.) Ralfs, 14b.
 S. sp., 1b, 8a, 12a, 14b, 16b.
 TETMEMORUS BREBISSEII (Menegh.) Ralfs, 17.
 T. LAEVIS (Kuetz.) Ralfs, 8.
 XANTHIDIUM ANTILOPAEUM (Breb.) Kuetz., 14b.
 X. ANTILOPAEUM var. POLYMAZUM Nordst., 1b, 8, 14b, 16.
 X. CRISTATUM Breb., 8.
 X. CRISTATUM var. UNCINATUM Breb., 14b.
 X. FASCICULATUM Ehr., 12a.
 X. SUBHASTIFERUM W. West, 14b.

Division—CHRYSTOPHYTA. Class—CHRYSTOPHYCEAE
 Order—CHRYSONOMADALES

1. Synuraceae

SYNURA UVELLA Ehr., 2b, 14b, 16b.

2. Ochromonadaceae

DINOBRYON BAVARICUM Imhof, 14b.

D. DIVERGENS Imhof, 11a, 14b, 16d.

D. SERTULARIA Ehr., 1b, 6, 14b.

Division—PYRRHOPHYTA. Class—DINOPHYCEAE
 Order—PERIDINIALES

1. Glenodiniaceae

GLENODINIUM sp., 14b, 17a.

2. Peridiniaceae

PERIDINIUM sp., 1b, 13.

3. Ceratiaceae

CERATIUM HIRUNDINELLA (O. F. Muell.) Dujardin, 1b, 2b, 7, 11a, 12c,
 13, 15, 16d, 17, 18c.

SUMMARY

1. This study of plankton algae is based upon collections taken from eighteen fresh water lakes from Whatcom County,

- Washington. The collections were made in 1929, 1949 and 1950.
2. A total of 220 species, 67 genera and 23 families was determined.
 3. The genera with the largest representation are as follows: *Cosmarium*, 26; *Staurastrum*, 19; *Closterium*, 16; *Euastrum*, 12; *Scenedesmus*, 12.
 4. The families represented by the largest number of species are the following: Desmidiaceae, 110; Chroococcaceae, 17; Oscillatoriaceae, 12; Nostocaceae, 12; Scenedesmaceae, 12.
 5. Terrell Lake had the most varied algal flora with 70 species, Judson Lake was second with 58 species, and Willey's Lake was third with 40 species.
 6. The paucity of literature concerning the fresh water algae of this area has prompted the writing of this paper. Since little or no prior investigation had been conducted on these particular lakes, the species herein reported represent for the most part new records for this locality.

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A CYTOTAXONOMIC STUDY OF THE GENUS GERANIUM IN THE WASATCH REGION OF IDAHO AND UTAH

RICHARD J. SHAW

Within the limits of the small but natural geographical area known as the Wasatch region, the genus *Geranium* has been given much needed intensive field study. The Wasatch region forms the western front of the Rocky Mountain province and extends 200 miles south from the great bend in the Bear River at Soda Springs, Idaho, to the pass south of Mount Nebo and east of Nephi, Utah (Fenneman, 1931) and includes twelve counties within these two states. The collections and the field studies of the species of *Geranium* found in this area, together